

## WHAT IS CLAIMED IS:

1. A color-separating and -recombining optical system comprising:

cubic- or square column-like first to fourth polarization beam splitters having polarization-splitting planes intersecting each other like a character-" X" ; and

wavelength-selective polarizing converters each for rotating the plane of polarization of a specific-color light component by 90 degrees, one of the converters being placed at a light-incident side of the first splitter, another of the converters being placed at a light-emitting side of the fourth splitter, the first and the fourth splitters being provided at a light-incident side and a light-emitting side, respectively, of the optical system, the first and the fourth splitters being arranged as diagonally opposing each other, and the remaining converters being placed between at least two inner facing planes of the first to the fourth splitters,

wherein at least the remaining converters and three of the first to the fourth splitters are joined each other to form an optical joint component with a gap between the remaining one splitter.

2. The color-separating and -recombining optical system according to claim 1, wherein the gap is filled with a buffer material.

3. The color-separating and -recombining optical system according to claim 1, wherein opto-elastic constants for the first to the fourth polarization beam splitters have a relationship  $K_i < K_m$  and  $K_o$  in which  $K_i$ ,  $K_m$  and  $K_o$  denote the opto-elastic constants for the first splitter, the second and the third splitters and the fourth splitter, respectively.

4. The color-separating and -recombining optical system according to claim 1, wherein opto-elastic constants for the first to the fourth polarization beam splitters have a

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relationship  $K_i$  and  $K_m < K_o$  in which  $K_i$ ,  $K_m$  and  $K_o$  denote the opto-elastic constants for the first splitter, the second and the third splitters and the fourth splitter, respectively.

5. The color-separating and -recombining optical system according to claim 1, wherein opto-elastic constants for the first to the fourth polarization beam splitters have a relationship  $K_i < K_m < K_o$  in which  $K_i$ ,  $K_m$  and  $K_o$  denote the opto-elastic constants for the first splitter, the second and the third splitters and the fourth splitter, respectively.

6. A color-separating and -recombining optical system comprising:

cubic- or square column-like first to fourth polarization beam splitters having polarization-splitting planes intersecting each other like a character-"X"; and

wavelength-selective polarizing converters each for rotating the plane of polarization of a specific-color light component by 90 degrees, one of the converters being placed at a light-incident side of the first splitter, another of the converters being placed at a light-emitting side of the fourth splitter, the first and the fourth splitters being provided at a light-incident side and a light-emitting side, respectively, of the optical system, the first and the fourth splitters being arranged as diagonally opposing each other, and the remaining converters being placed between at least two inner facing planes of the first to the fourth splitters,

wherein opto-elastic constants for the first to the fourth splitters have a relationship  $K_i < K_m$  and  $K_o$ ,  $K_i$  and  $K_m < K_o$  or  $K_i < K_m < K_o$  in which  $K_i$ ,  $K_m$  and  $K_o$  denote the opto-elastic constants for the first splitter, the second and the third splitters and the fourth splitter, respectively.

7. The color-separating and -recombining optical system according to claim 6, wherein the first to the fourth polarization beam splitters and the wavelength-selective polarizing converters are joined each other.

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8. A color-separating and -recombining optical system comprising:

cubic- or square column-like first to fourth polarization beam splitters having polarization-splitting planes intersecting each other like a character-" X" ;

wavelength-selective polarizing converters each for rotating the plane of polarization of a specific-color light component by 90 degrees, one of the converters being placed at a light-incident side of the first splitter, another of the converters being placed at a light-emitting side of the fourth splitter, the first and the fourth splitters being provided at a light-incident side and a light-emitting side, respectively, of the optical system, the first and the fourth splitters being arranged as diagonally opposing each other, and the remaining converters being placed between at least two inner facing planes of the first to the fourth splitters; and

a light blockage provided at an intersection of the polarization-splitting planes and surrounded by the first to the fourth splitters, the light blockage preventing light leakage from the first to the fourth splitters.

9. A color-separating and -recombining optical system comprising:

cubic- or square column-like first to fourth polarization beam splitters having polarization-splitting planes intersecting each other like a character-" X" ;

wavelength-selective polarizing converters each for rotating the plane of polarization of a specific-color light component by 90 degrees, one of the converters being placed at a light-incident side of the first splitter, another of the converters being placed at a light-emitting side of the fourth splitter, the first and the fourth splitters being provided at a light-incident side and a light-emitting side, respectively, of the optical system, the first and the fourth splitters being arranged as diagonally opposing each other, and the remaining converters being placed between at least two inner facing planes

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of the first to the fourth splitters; and

first light blockages provided at a first corner of the cubic- or square column-like first splitter and a second corner of the cubic- or square column-like fourth splitter, edges of the first and the second corners diagonally opposing each other being cut off to be flat to face each other, the first light blockages preventing light leakage from the first to the fourth splitters.

10. The color-separating and -recombining optical system according to claim 9 further comprising second light blockage provided at a light-emitting side plane of the fourth beam splitter for preventing light leakage from the first to the fourth beam splitters.

11. A projection display comprising:

a light source for emitting unlinearly-polarized light;

a first polarizer to allow only a first specific-linearly-polarized light component of the unlinearly-polarized light to pass therethrough;

a color-separating and -recombining optical system including cubic- or square column-like first to fourth polarization beam splitters having polarization-splitting planes intersecting each other like a character-" X" , the first splitter being provided as facing the first polarizer, and wavelength-selective polarizing converters each for rotating the plane of polarization of a specific-color light component by 90 degrees, one of the converters being placed at a light-incident side of the first splitter, another of the converters being placed at a light-emitting side of the fourth splitter, the first and the fourth splitters being provided at a light-incident side and a light-emitting side, respectively, of the optical system, the first and the fourth splitters being arranged as diagonally opposing each other, and the remaining converters being placed between at least two inner facing planes of the first to the fourth splitters, wherein at least the remaining converters and three of the first to the fourth splitters are joined each other to

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form an optical joint component with a gap between the remaining one splitter;

reflective spatial light modulators for light modulation in accordance with a video signal, provided outside the optical system, as facing each light-passing plane of the second and the third splitters,

a second polarizer provided as facing a light-emitting side plane of the fourth splitter, to allow only a second specific-linearly-polarized light component emitted from the light-emitting side plane of the fourth splitter to pass therethrough; and

a projection lens provided as facing the second polarizer, to receive the second specific-linearly-polarized light component for image projection.

12. A projection display comprising:

a light source for emitting unlinearly-polarized light;

a first polarizer to allow only a first specific-linearly-polarized light component of the unlinearly-polarized light to pass therethrough;

a color-separating and -recombining optical system including cubic- or square column-like first to fourth polarization beam splitters having polarization-splitting planes intersecting each other like a character-" X" , the first splitter being provided as facing the first polarizer, and wavelength-selective polarizing converters each for rotating the plane of polarization of a specific-color light component by 90 degrees, one of the converters being placed at a light-incident side of the first splitter, another of the converters being placed at a light-emitting side of the fourth splitter, the first and the fourth splitters being provided at a light-incident side and a light-emitting side, respectively, of the optical system, the first and the fourth splitters being arranged as diagonally opposing each other, and the remaining converters being placed between at least two inner facing planes of the first to the fourth splitters, wherein opto-elastic constants for the first to the fourth splitters have a relationship  $K_i < K_m$  and  $K_o$ ,  $K_i$  and  $K_m$

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$< K_o$  or  $K_i < K_m < K_o$  in which  $K_i$ ,  $K_m$  and  $K_o$  denote the opto-elastic constants for the first splitter, the second and the third splitters and the fourth splitter, respectively;

reflective spatial light modulators for light modulation in accordance with a video signal, provided outside the optical system, as facing each light-passing plane of the second and the third splitters,

a second polarizer provided as facing a light-emitting side plane of the fourth splitter, to allow only a second specific-linearly-polarized light component emitted from the light-emitting side plane of the fourth splitter to pass therethrough; and

a projection lens provided as facing the second polarizer, to receive the second specific-linearly-polarized light component for image projection.

13. A projection display comprising:

a light source for emitting unlinearly-polarized light;

a first polarizer to allow only a first specific-linearly-polarized light component of the unlinearly-polarized light to pass therethrough;

a color-separating and -recombining optical system including cubic- or square column-like first to fourth polarization beam splitters having polarization-splitting planes intersecting each other like a character-" X" , the first splitter being provided as facing the first polarizer, wavelength-selective polarizing converters each for rotating the plane of polarization of a specific-color light component by 90 degrees, one of the converters being placed at a light-incident side of the first splitter, another of the converters being placed at a light-emitting side of the fourth splitter, the first and the fourth splitters being provided at a light-incident side and a light-emitting side, respectively, of the optical system, the first and the splitters being arranged as diagonally opposing each other, and the remaining converters being placed between at least two inner facing planes of the first to the fourth splitters, and a light blockage provided at an intersection of

the polarization-splitting planes and surrounded by the first to the fourth splitters, the light blockage preventing light leakage from the first to the fourth splitters;

reflective spatial light modulators for light modulation in accordance with a video signal, provided outside the optical system, as facing each light-passing plane of the second and the third splitters,

a second polarizer provided as facing a light-emitting side plane of the fourth splitter, to allow only a second specific-linearly-polarized light component emitted from the light-emitting side plane of the fourth splitter to pass therethrough; and

a projection lens provided as facing the second polarizer, to receive the second specific-linearly-polarized light component for image projection.

14. The projection display according to claim 13, wherein the second and the third polarization beam splitters are made smaller than the first and the fourth polarization beam splitters.

15. The projection display according to claim 14 further comprising optical couplers provided at least between the first and the second polarization beam splitters and the second and the fourth polarization beam splitters.

16. The projection display according to claim 14, wherein a first optical length from the light source to each reflective spatial light modulator is almost equal to a second optical length from each reflective spatial light modulator to the projection lens.

17. A projection display comprising:

a light source for emitting unlinearly-polarized light;

a first polarizer to allow only a first specific-linearly-polarized light component of the unlinearly-polarized light to pass therethrough;

a color-separating and -recombining optical system

including cubic- or square column-like first to fourth polarization beam splitters having polarization-splitting planes intersecting each other like a character-" X" , the first splitter being provided as facing the first polarizer, wavelength-selective polarizing converters each for rotating the plane of polarization of a specific-color light component by 90 degrees, one of the converters being placed at a light-incident side of the first splitter, another of the converters being placed at a light-emitting side of the fourth splitter, the first and the fourth splitters being provided at a light-incident side and a light-emitting side, respectively, of the optical system, the first and the splitters being arranged as diagonally opposing each other, and the remaining converters being placed between at least two inner facing planes of the first to the fourth splitters, and light blockages provided at a first corner of the cubic- or square column-like first splitter and a second corner of the cubic- or square column-like fourth splitter, edges of the first and the second corners diagonally opposing each other being cut off to be flat to face each other, the light blockages preventing light leakage from the first to the fourth splitters;

reflective spatial light modulators for light modulation in accordance with a video signal, provided outside the optical system, as facing each light-passing plane of the second and the third splitters,

a second polarizer provided as facing a light-emitting side plane of the fourth splitter, to allow only a second specific-linearly-polarized light component emitted from the light-emitting side plane of the fourth splitter to pass therethrough; and

a projection lens provided as facing the second polarizer, to receive the second specific-linearly-polarized light component for image projection.

18. The projection display according to claim 17, wherein the second and the third polarization beam splitters are made smaller than the first and the fourth polarization beam splitters.

20. The projection display according to claim 18, wherein a first optical length from the light source to each reflective spatial light modulator is almost equal to a second optical length from each reflective spatial light modulator to the projection lens.